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EXAMINER	
UMEZ ERONINI, LYNETTE T	
ART UNIT	**PAPER NUMBER**
1765	

DATE MAILED: 01/08/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/909,112	OEY HEWETT ET AL.
	Examiner	Art Unit
	Lynette T. Umez-Eronini	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 10/6/03.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-56 is/are pending in the application.

4a) Of the above claim(s) 35-52 is/are withdrawn from consideration.

5)☐ Claim(s) ______ is/are allowed.

6)☒ Claim(s) 1-34 is/are rejected.

7)☒ Claim(s) 53-56 is/are objected to.

8)☐ Claim(s) ______ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on ______ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. §§ 119 and 120

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ______.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

13)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

a) ☐ The translation of the foreign language provisional application has been received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) ______.
4) ☐ Interview Summary (PTO-413) Paper No(s). ______.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 102

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1-26 are rejected under 35 U.S.C. 102(b) as being anticipated by Muraka et al. (US 5,637,185).

Murarka teaches, "A system for performing chemical mechanical planarization for a semiconductor wafer includes a chemical mechanical polishing system including a chemical mechanical polishing slurry" (Abstract). "Substrates used for polishing were . . . silicon wafers" (column 10, lines 39-40). "A thin metal liner film . . . was sputter deposited . . . followed by a . . . thick copper film . . . Both annealed and unannealed copper films were polished" (column 10, lines 46-53 and column 5, lines 1-9). The aforementioned reads on,

A method, comprising:

providing a substrate having a metal layer formed there above;

performing a chemical mechanical polishing process on said layer of metal in the presence of a polishing slurry;

Murarka, further teaches, "Changes in the measured electrochemical potential slurry during processing indicate the stage of the CMP process, as material is abraded from the surface of a layer being polished, and as the concentrations of abraded

material in the slurry change" (column 9, lines 13-17). Murarka shows in equation (3), a modified form of the Nerst equation, which shows the relationship between the electrode potential and concentration of copper (column 10, lines 24-26), which reads on,

measuring at least a concentration of a material comprising said metal layer in said polishing slurry used during said polishing process after at least some of said polishing process has been performed.

Murarka teaches, " . . . the composition of the slurry in the region proximate the wafer changes during polishing. For example, when polishing a copper layer, the concentration of copper ions . . . in the slurry will change during polishing, initially increasing, and then decreasing as the copper material is removed and the underlying surface is reached" (column 8, lines 7-14), which provides evidence that the copper (metal) ion concentration in the slurry varies as the copper layer is removed from the surface of a wafer. Since it is well known in the art that a layer of material is measured in term of length (thickness), then using Muraka's method of measuring the metal concentration that varies as the metal layer is polished from the surface of a metal layer would inherently result in,

determining a thickness of said layer of metal removed during said polishing process based upon at least said measured concentration of said material (same as applicant's copper) comprising said metal layer, **as in claims 1, 11, and 20**.

Murarka teaches, " . . . a much wider range of film materials and process conditions (i.e., pressure, rotational velocities, slurry compositions, slurry delivery and flow rates, etc.) can also be used in accordance with the present invention" (column 9, lines 26-30) and "CMP system can also include control means **64** for receiving and analyzing data received from end point detector means **B**. Control means **B** is capable of generating signals for controlling the operation parameters of the system in response to the data received" (column 8, lines 57-61) which reads on, adjusting at least one parameter of said polishing process based upon said determined thickness of said layer of metal removed during said polishing process, **in claims 2, 12, and 21**.

Murarka teaches, " . . . 250 ml/min were delivered during polishing" (column 11, lines 59-61) and ". . . shows that the potential measurement may be used to monitor the progress of the polishing and predict the polish rate, which makes this invention useful as an in situ process monitor" (column 13, lines 7-12), which reads on measuring a volume of said polishing slurry during said polishing process, **in claims 3, 13, and 22**; and measuring a volume of a material said polishing slurry used during said polishing process comprises measuring a volume of a said polishing slurry during said polishing process using a volumetric meter, **in claim 8, 17, and 26**.

It is known in the art that the amount of slurry can be expressed in terms of concentration and volume. Murarka has established the amount of metal in a polishing slurry varies as the metal is removed from a layer (see column 8, lines 7-14), which provides evidence for measuring the concentration of a material comprising a metal in

the polishing slurry. Similarly one can express the amount of slurry in terms of volume and measure the electrode potential of a give volume of slurry. Based upon the amount of the electrode potential obtained, one can find the corresponding length (thickness) of metal removed from the substrate during polishing and prepare a calibration curve of or find a correlation using a least square fit between the volume and thickness of metal removed, which can be used in formulating an empirical equation that shows the relationship between volume of slurry and thickness removed. By comparison of the calibration curve and by solving an empirical equation, thickness of the metal material removed can be determined. Hence, the aforementioned reads on,

calculating a thickness of said layer of metal removed during said polishing process based upon at least the measured volume of said polishing slurry used during said polishing operation, **in claims 4, 14, and 23**;

calculating a thickness of said layer of metal removed during said polishing process based upon at least the measured volume of said polishing slurry used during said polishing operation and said measured concentration of said material comprising said metal layer, **in claim 5, 15, and 24**;

wherein said step of determining a thickness of said layer of metal removed during said polishing process comprises accessing a model comprised of data correlating said measured concentration of said material comprising said layer of metal and a thickness of a layer of material comprised of the same material as said layer of meat, **in claims 9 and 18**;

calculating said layer of metal removed during said polishing process based upon at least said measured concentration, **in clam 10**;

wherein said step of determining a thickness of said layer of metal removed during said polishing process comprises calculating a thickness of said layer of metal removed during said polishing process based upon at least said measured concentration, **in claim 19**.

Murarka teaches, "The voltmeter records changes in the electrochemical potential of the slurry during processing as measured by the measurement electrode relative to the reference electrochemical potential measurement of the slurry prior to entering the system" (column 3, lines 34-38), which reads on measuring a concentration of a material comprising said metal layer comprises measuring a concentration of a material comprising said metal layer using a concentration monitor, **in claim 7, 16, and 25**.

3. Claims 27-29 are rejected under 35 U.S.C. 102(b) as being anticipated by Muraka et al. (US '185).

As pertaining to claims 27 and 29, Murarka teaches, "A system for performing chemical mechanical planarization for a semiconductor wafer includes a chemical mechanical polishing system including a chemical mechanical polishing slurry" (Abstract). "Substrates used for polishing were . . . silicon wafers" (column 10, lines 39-40). "A thin metal liner film . . . was sputter deposited . . . followed by a . . . thick copper

film . . . Both annealed and unannealed copper films were polished" (column 10, lines 46-53 and column 5, lines 1-9). The aforementioned reads on,

A method, comprising:

providing a substrate having a metal layer comprised of copper formed there above;

performing a chemical mechanical polishing process on said layer of metal in the presence of a polishing slurry;

Murarka, further teaches, "Changes in the measured electrochemical potential slurry during processing indicate the stage of the CMP process, as material is abraded from the surface of a layer being polished, and as the concentrations of abraded material in the slurry change" (column 9, lines 13-17). Murarka shows in equation (3), a modified form of the Nerst equation, which shows the relationship between the electrode potential and concentration of copper (column 10, lines 24-26), which reads on

measuring at least a concentration of copper in said polishing slurry used during said polishing process after at least some of said polishing process has been performed.

Murarka teaches, " . . . the composition of the slurry in the region proximate the wafer changes during polishing. For example, when polishing a copper layer, the concentration of copper ions . . . in the slurry will change during polishing, initially increasing, and then decreasing as the copper material is removed and the underlying surface is reached" (column 8, lines 7-14), which provides evidence that the copper

(metal) ion concentration in the slurry varies as the copper layer is removed from the surface of a wafer. Since it is well known in the art that a layer of material is measured in term of length (thickness), then one can express the concentration of copper removed from the layer in terms of the electrode potential of copper in slurry during polishing. Based upon the value of the electrode potential obtained, one can find the corresponding length (thickness) of copper removed from the substrate during polishing and prepare a calibration curve of or find a correlation using a least square fit between the concentration of copper and thickness of metal removed, which can be used in formulating an empirical equation that shows the relationship between volume of slurry and thickness removed. By comparison of the calibration curve and by solving an empirical equation, thickness of the metal material removed can be determined. Hence, the said aforementioned reads on,

calculating a thickness of said layer of metal removed during said polishing process based upon at least the measured volume of said measured concentration of copper; and

determining a thickness of said layer of metal removed during said polishing process by accessing a model comprised of data correlating said measured concentration of copper and a thickness of a layer of copper.

Murarka teaches, " . . . a much wider range of film materials and process conditions (i.e., pressure, rotational velocities, slurry compositions, slurry delivery and flow rates, etc.) can also be used in accordance with the present invention" (column 9,

lines 26-30) and "CMP system can also include control means **64** for receiving and analyzing data received form end point detector means **B**. Control means **B** is capable of generating signals for controlling the operation parameters of the system in response to the data received" (column 8, lines 57-61) which reads on, adjusting at least one parameter of said polishing process based upon said determined thickness of said layer of metal removed during said polishing process, **in claim 28**.

4. Claims 30-34 are rejected under 35 U.S.C. 102(b) as being anticipated by Murarka et al. (US '185).

As pertaining to claims 30, 32, 33, and 34, Murarka teaches, "A system for performing chemical mechanical planarization for a semiconductor wafer includes a chemical mechanical polishing system including a chemical mechanical polishing slurry" (Abstract). "Substrates used for polishing were . . . silicon wafers" (column 10, lines 39-40). "A thin metal liner film . . . was sputter deposited . . . followed by a . . . thick copper film . . . Both annealed and unannealed copper films were polished" (column 10, lines 46-53 and column 5, lines 1-9). The aforementioned reads on,

A method, comprising:

providing a substrate having a metal layer comprised of copper formed there above; and

performing a chemical mechanical polishing process on said layer of metal in the presence of a polishing slurry.

Murarka teaches, "Approximately 150 ml of slurry was delivered to the pad before polishing began and 250 ml/min were delivered during polishing" (column 11, lines 59-61) and " . . . shows that the potential measurement may be used to monitor the progress of the polishing and predict the polish rate, which makes this invention useful as an in situ process monitor" (column 13, lines 7-12), which read on,

measuring a volume of said polishing slurry used during said polishing process after at least some of said polishing process has been performed.

Murarka, further teaches, "Changes in the measured electrochemical potential slurry during processing indicate the stage of the CMP process, as material is abraded from the surface of a layer being polished, and as the concentrations of abraded material in the slurry change" (column 9, lines 13-17). Murarka shows in equation (3), a modified from of the Nerst equation, which shows the relationship between the electrode potential and concentration of copper (column 10, lines 24-26). It is known in the art that the amount of slurry can be expressed in terms of concentration and volume. Murarka has established the amount of metal in a polishing slurry varies as the metal is removed from a layer in column 8, lines 7-14, which further provides evidence for measuring the concentration of a material comprising a metal in the polishing slurry. Similarly one can express the amount of slurry in terms of volume and measure the electrode potential of a give volume of slurry. Based upon the amount of the electrode potential obtained, one can find the corresponding length (thickness) of metal removed from the substrate during polishing and prepare a calibration curve of or find a correlation using a least square fit between the volume and thickness of metal removed,

which can be used in writing an empirical equation that shows the relationship between volume of slurry and thickness removed. By comparison of the calibration curve or by solving an empirical equation, thickness of the metal material removed can be determined. Hence the above aforementioned reads on,

calculating a thickness of said layer of metal removed during said polishing process based upon at least said measured volume of polishing slurry and said measured concentration of copper.

Murarka teaches, " . . . a much wider range of film materials and process conditions (i.e., pressure, rotational velocities, slurry compositions, slurry delivery and flow rates, etc.) can also be used in accordance with the present invention" (column 9, lines 26-30) and "CMP system can also include control means **64** for receiving and analyzing data received from end point detector means **B**. Control means **B** is capable of generating signals for controlling the operation parameters of the system in response to the data received" (column 8, lines 57-61) which reads on, adjusting at least one parameter of said polishing process based upon said determined thickness of said layer of metal removed during said polishing process, **in claim 31**.

Allowable Subject Matter

5. Claims 53-56 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

6. The following is a statement of reasons for the indication of allowable subject matter: No prior art teach or suggest measuring the concentration of copper in a polishing slurry that is collected in a waste slurry reservoir.

Response to Arguments

7. Applicants' arguments filed October 6, 2003 have been fully considered but they are not persuasive. Applicants traverse the 102(b) rejection of claims 1-34 as being anticipated by Murarka (US 5,637,185). Applicants' arguments are summarized as follow: Murarka fails to teach -

determining a thickness of the layer of metal that is removed during the polishing operation based upon at least the measured concentration of the metal layer material, in claims 1, 11, and 20;

calculating the thickness of the metal layer removed during the polishing process based upon the measured volume of the polishing slurry used during the polishing operations, in claims 4, 14, and 23;

calculating the thickness of the metal layer removed by the measured volume of polishing slurry and the measured concentration of the material of the metal layer in the polishing slurry, in claims 5,15, and 24;

determining the thickness of the metal layer removed is determined by accessing a model that is comprised of data correlating the measured concentration of the layer of metal in the slurry and the thickness of a layer of material comprised of the same material as the layer of metal, in claims 9 and 18;

determining the thickness of the metal layer removed during polishing by accessing a model that is comprised of data correlating the measured concentration of copper and a thickness of a layer of copper in claims 27-29; and

measuring the volume of slurry used during the polishing process, measuring the concentration of the copper in the measured volume of slurry, and calculating a thickness of the layer of metal removed based upon at least the measured volume of the slurry and the measured concentration of copper, in claims 30-34.

Applicants' arguments are unpersuasive because Murarka teaches, "As a result of these and other interactions at the surface of the wafer being polished, the composition of the slurry in the region proximate the wafer changes during polishing. For example, when polishing a copper layer, the concentration of copper ions and other copper compounds in the slurry will change during polishing, initially increasing, and then decreasing as the copper material is removed and the underlying surface is reached. As explained quantitatively below, changes in the concentrations of materials in the slurry during processing can be determined by monitoring changes in the electrochemical potential of the slurry during CMP. For example, changes in the electrochemical potential of the slurry in the region adjacent the wafer can initially reflect an increase in the concentration of the abraded material and eventually a decrease in the concentration of the abraded material as the layer is removed. Changes in the electrochemical potential of the slurry can also reflect that a layer has been removed and an underlying layer, such as a metal liner layer, has been reached. These changes

in the measured electrochemical potential of the slurry during processing signal the end point of the process" (column 8, lines 7-28). Murarka, further teaches, "Changes in the measured electrochemical potential slurry during processing indicate the stage of the CMP process, as material is abraded from the surface of a layer being polished, and as the concentrations of abraded material in the slurry change" (column 9, lines 13-17). Murarka shows in equation (3), a modified form of the Nerst equation, which shows the relationship between the electrode potential and concentration of copper (column 10, lines 24-26), Murarka also teaches, "Because the mixed potential involves unknown variables, the concentration of copper ions in the slurry is not easily calculated directly from a measurement of the mixed potential. However, relative changes in ion concentration can be inferred from changes in the mixed potential" (column 10, lines 12-16), which further suggests that the concentration of copper in the slurry is measured.

Murarka teaches, " . . . 250 ml/min were delivered during polishing" (column 11, lines 59-61) and " . . . shows that the potential measurement may be used to monitor the progress of the polishing and predict the polish rate, which makes this invention useful as an in situ process monitor" (column 13, lines 7-12), which reads on measuring a volume of said polishing slurry during said polishing process

Murarka teaches, "Prior to planarization, a reference electrode, designated as 56 in FIGS. 3A and 3B, is used to obtain the reference electrochemical potential measurement of the slurry. For example, the electrochemical potential of a bulk solution of the slurry can be measured with reference electrode 56 prior to conducting

the CMP process of the invention. The resultant electrochemical potential measurement of the bulk solution provides a baseline or reference electrochemical potential measurement, against which changes in the potential of the slurry can be monitored during processing, as explained below." Hence the aforementioned suggests that the concentration and volume of the bulk slurry solution is measured. Murarka has established the amount of metal in a polishing slurry varies as the metal is removed from a layer (see column 8, lines 7-14), which provides evidence for measuring the concentration of a material comprising a metal in the polishing slurry. Similarly one can express the amount of slurry in terms of volume and measure the electrode potential of a give volume of slurry. Based upon the amount of the electrode potential obtained, one can find the corresponding length (thickness) of metal removed from the substrate during polishing and prepare a calibration curve of or find a correlation using a least square fit between the volume and thickness of metal removed, which can be used in formulating an empirical equation that shows the relationship between volume of slurry and thickness removed. By comparison of the calibration curve and by solving an empirical equation, thickness of the metal material removed can be determined. Hence the above aforementioned reads on,

calculating a thickness of a metal (copper) layer removed during said polishing process based upon at least said measured volume of polishing slurry and said measured concentration of copper and determining the thickness of the metal layer removed is determined by accessing a model that is comprised of data correlating the

measured concentration of the layer of metal in the slurry and the thickness of a layer of material comprised of the same material as the layer of metal.

Conclusion

8. **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lynette T. Umez-Eronini whose telephone number is 571-272-1470. The examiner can normally be reached on unavailable on the First Friday.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nadine Norton can be reached on 571-272-1435. The fax phone number

for the organization where this application or proceeding is assigned is (571) 271-02239.

ROBERT KUNEMUND
PRIMARY EXAMINER

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December 24, 2003